MC252 Deepwater Horizon Oil Spill
Water Column Data Collection

NOAA/BP-ENTRIX NRDA Cooperative Deep Tow Cruise 1
November 2010 Arctic-HOS Davis 4 Cruise Plan

November 21, 2010

Approvals

Approval of this work plan is for the purposes of obtaining data for the Natural Resource Damage Assessment. Parties each reserve its right to produce its own independent interpretation and analysis of any data collected pursuant to this work plan. Signature by Trustee representatives is not intended to and should not be taken to approve or endorse Cardno ENTRIX appendices.

BP Approval:

Robin Bullock	Robin Bullock	11/23/10
Printed Name	Signature	Date

Federal Trustee Approval:

Jessica White	Jessica White	11/22/10
Printed Name	Signature	Date

Louisiana Approval:

Printed Name	Signature	Date

DWH-AR0013626

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November 2010 Arctic-HOS Davis 4 Cruise Plan

Sampling Vessels: M/V *Arctic,* M/V *HOS Davis, M/V Nick Skansi*
Supply Vessel: M/V *Emily Bordelon*

November 21, 2010

Proposed Cruise Dates: November 2, 2010 – November 17, 2010

Prepared by: Deborah French-McCay, Jenna Cragan, Eileen Graham (ASA), on behalf of Trustees
Tim Thompson, Jodi Harney, Laura Riege (Cardno ENTRIX), on behalf of BP

Reviewed by: Dan Hahn (NOAA)

Overview

This November Cruise Plan, developed as a cooperative and collaborative effort by representatives of both Trustees/NOAA and BP/ENTRIX, will collect water column data in the vicinity of the MC252 well site and areas to the south, east and northeast. A substantial focus of this cruise will be the utilization of deep-tow instrumentation to collect real-time water quality data from the depth range (900-1400 m) in which indicators of subsurface hydrocarbons (e.g. fluorescence peaks and dissolved oxygen [DO] sags) have been identified in previous studies. Full-depth water column profiling with CTD and other instrumentation will be conducted at locations along and adjacent to the deep-tow transect lines where deep-tow instrumentation indicates presence of subsurface hydrocarbons. Adaptive water bottle sampling will be performed at these sample stations in and surrounding fluorescence peaks or DO sags. As warranted, near bottom water samples may also be collected in areas where indications of sedimented oil or floc are noted during bottom surveys with a Remotely Operated Vehicle (ROV).

The principal objective of this proposed cruise is to measure physical and chemical properties of the water column, including the concentrations of subsurface hydrocarbons and dispersant related to the MC252 Incident, in several areas near the MC252 well site. The study area is primarily to the east and northeast of the well site, including portions of DeSoto Canyon (Figure 1). Previous researchers and sampling compiled by the NOAA SMU response group (summarized in the Mission Guidance daily reports) indicate that DeSoto Canyon was potentially exposed to oil from the MC252 incident (for example, a May 2010 study aboard the R/V

Weatherbird II). Two locations sampled during that cruise will be re-sampled during this cooperative cruise; as well as nearby areas, recognizing that the water and any contamination observed in May has likely moved with currents since that time.

During the proposed cruise, fluorescence and dissolved oxygen indicators will be measured by the *Arctic* (deploying instruments in deep-tow mode) and a water sampling vessel, the *HOS Davis* (deploying instruments in cast mode). Water samples for analytical chemistry will also be collected by the two vessels to measure the concentrations of sub-surface oil, dissolved hydrocarbons, and dispersant indicators in sampled locations. Bathymetry is required in advance of deep-tow operations to identify subsurface hazards and to ensure sufficient seafloor clearance for the tow fish. A third vessel, the *Nick Skansi,* will conduct acoustic surveys along pre-determined transect lines to collect the necessary bathymetric data. The numbering of the transects suggests an order for efficient sampling, but based on weather and sea conditions, the order and direction of the transects may be changed to facilitate the work. In addition and with agreement by trustee and BP science leads, the transect paths may be altered slightly to avoid hazards identified by the acoustic surveys.

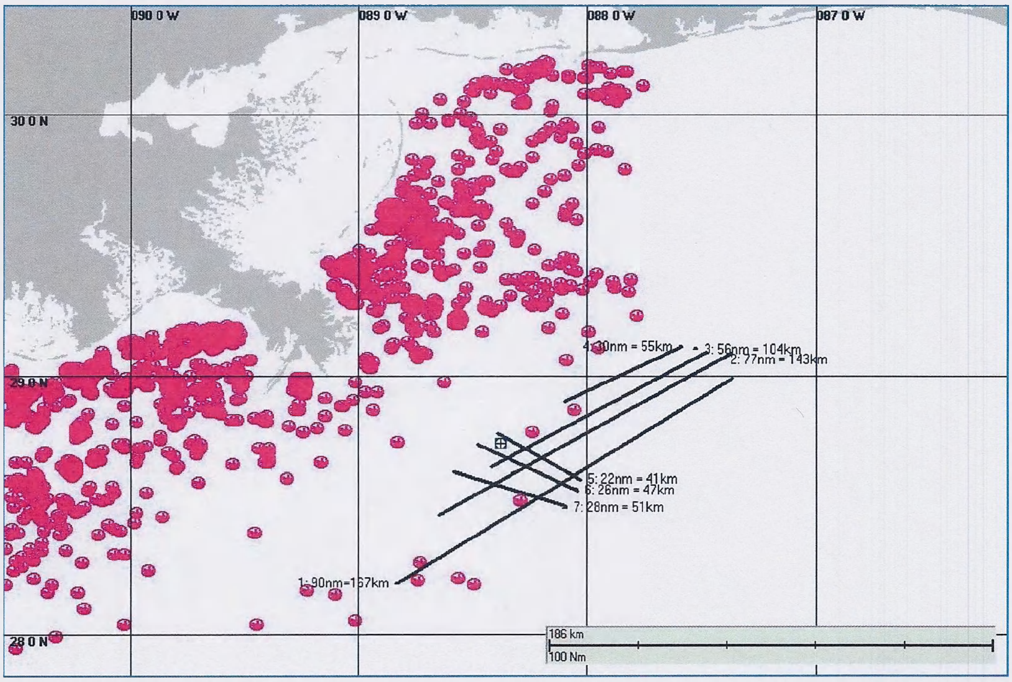

Figure 1. Region of interest and deep-tow sampling locations for the *Arctic*. Red symbols indicate locations of offshore platforms (potential obstacles for towing). Adaptive sampling will occur at locations selected in real-time based upon initial results observed with towed instruments and/or at sampled stations.

Applicable protocols are provided as appendices to this plan (e.g. water sampling; sampling handling, naming conventions, COC templates, QA/QC procedures, and NOAA QAP; Attachments 7-11).

Cruise Objectives and Approach

The Collaborative Deep-Tow Cruise proposed here is designed to address the following objectives:

1. Conduct long-transect surveys using the deep-tow platform to collect *in situ* data and water samples within a targeted depth range.
2. Use a sampling vessel to measure physical and chemical properties of the water column at adaptively-selected locations.
3. Determine concentrations of subsurface hydrocarbons and dispersant related to the MC252 Incident.

The overall focus of this collaborative study is to evaluate the presence, concentrations and sources of subsurface oil in specified areas and water depths. Both pre-determined transect lines and adaptive sampling techniques will be employed to evaluate conditions on and near transect lines. This cruise plan utilizes acoustic instruments, oceanographic profiling instruments (CTD/DO/fluorescence), a laser in-situ scattering and transmissometer (LISST-DEEP), an acoustic backscatter sensor (ABS), an underwater *in situ* Membrane Introduction Mass Spectrometer (MIMS) operated by Stanford Research International, and water column sampling to measure the physical and chemical properties of the water column. This information is useful for understanding current marine conditions and the potential oil fate.

A customized towfish platform constructed for the *Arctic* deep-tow vessel enables the packaging of a water sampling rosette with the CTD/DO sensors, LISST-DEEP, ABS, MIMS, and fluorometers (Figure 2). The towfish platform can be deployed in deep-tow mode at a single depth or with low-frequency oscillations over a range of depths. An acoustic survey will be conducted prior to deep-tow operations to measure bathymetry and identify sub-surface hazards. The acoustic Ultra-Short Baseline (USBL) method will be used to calculate the relative position of the towfish platform behind the vessel during all deep-tow operations.

Figure 2. Custom towfish platform which enables simultaneous deployment of the CTD/DO, fluorometer, MIMS, and water sampling rosette.

Specific components of sample and data collection proposed in this cruise plan include:

1. Acoustic surveying using a dual-frequency (38 kHz and 200 kHz) single-beam echo sounder to measure along the cruise track water column backscatter, stratification, and any anomalies potentially related to sub-surface hydrocarbons, oil plumes, and/or natural seeps. Acoustic surveying will also provide the bathymetric data necessary for safe deep-tow operations.
2. Measurement of Conductivity, Temperature, Depth (CTD), and dissolved oxygen (DO) *in situ* to measure the physical characteristics and vertical density structure of the water column (e.g. thermoclines and pycnoclines).
3. Measurement of UV fluorescence *in situ* and real-time using sensors packaged with the CTD instrument. Three fluorometers will be employed simultaneously on the HOS Davis: a WetLabs CDOM, an ECO-FL, and a Chelsea AquaTracka. Two fluorometers will be employed simultaneously on the Arctic: a WetLabs CDOM and a Chelsea AquaTracka. These instruments utilize different excitation and emission wavelengths, with the AquaTracka designed to be sensitive to fluorescence from hydrocarbons. The CDOM is designed to measure fluorescence from dissolved organic matter and the ECO-FL measures fluorescence from chlorophyll.
4. Deployment and deep-towing of the LISST-DEEP and ABS to detect and quantify the presence of particles, including oil/gas droplets/bubbles, *in situ.*
5. Deployment of the underwater MIMS instrument to detect and quantify the presence of dissolved gases and volatile organics *in situ*.

6. Deployment of a water sampling rosette (on both the *Arctic* and the *HOS Davis*) or water bottles mounted on the Tether Management System (TMS) of the ROV (on the *HOS Davis)* to collect whole water samples, at locations and depths where sensors indicate potential presence of hydrocarbons, for measurement of the following chemicals in accordance with the attached protocols and NOAA Analytical Quality Assurance Plan (QAP); Attachments 8-9:
    - Extended PAH (parent plus alkylated PAHs) as described in QAP Table 1.1a;
    - Saturated Hydrocarbons and Total Hydrocarbons as described in QAP Table 1.1b
    - VOCs as described in QAP Table 1.1c, pending a joint BP/Trustee agreement to discontinue VOC analyses project-wide.
    - TSS, CHN
    - Dispersant concentrations by LC/MS/MS (DOSS), and semi-quantitative analysis of monitoring ion profiles by GC/MS-SIM for dispersant indicator compounds (DPnB m/z 59 and 103)
    - Methane (for comparison with MIMS measurements)
7. Real-time ROV video imaging for general seafloor observations (on board the *HOS Davis*; Attachment 6).

In addition, two APEX floats that were deployed off the *HOS Davis* 1 cruise will be recovered for servicing (by the *Nick Skansi* or *Emily Bordelon*). We will deploy 6 more APEX floats (off the *Arctic*) to tract water movements. These floats (Attachment 3) are designed to be neutrally buoyant and record location as they move with ambient currents.

Sampling Plan

As illustrated in Figure 1, data and samples will be collected in several areas south, southeast, and east of the MC252 well site. Pre-defined transect lines totaling 329 nautical miles (618 kilometers) in length will be surveyed by the *Arctic* using the deep-tow instrument platform (Figures 1, 3; Table 1). The position and orientation of these transects are selected based on observations that the deep currents generally flow parallel or nearly parallel to bathymetric contours (as indicated by literature and drifter experiments, see Attachment 3). The transects are oriented either along the general trend of these contours or transverse to evaluate if measurable concentrations of subsurface hydrocarbons exist in these locations.

We plan to collect water samples from the *HOS Davis* at approximately 42 sampling locations which will be positioned along or adjacent to *Arctic* survey lines in order to measure concentrations of hydrocarbons at these locations. The specific sampling locations will be selected adaptively based on the results of the *Arctic* deep-tow instrumentation measurements and other sampling from the *HOS Davis*. The Chief Scientist on the *HOS Davis*, Dr. James Payne, will select these locations after consultation with Dr. Deborah French-McCay and Dr. Yong Kim of ASA, and the ENTRIX science lead(s), as appropriate and timely.

Water sampling will also be performed using the rosette on the *Arctic* tow-fish, but water sampling will be timed such that it does not interfere with the deep-towing operations, planned transect lengths, and planned times for bringing the tow-fish to the surface. Dr. Yong Kim, Chief Scientist on the Arctic, will select these locations after consultation with Dr. French-McCay and Dr. Payne, and the ENTRIX science lead(s), as appropriate and timely.

Table 1. Survey line end point coordinates (degrees), line lengths, and cast sampling locations shown in Figure 1.

Number (Order)	Direction	Start: Latitude	Start: Longitude	Stop: Latitude	Stop: Longitude	Length (nmile)	Length (km)
1	W-E	28.20500	88.83133	28.99200	87.36600	90	167
2	E-W	29.08700	87.37000	28.46850	88.65233	77	143
3	W-E	28.65400	88.42017	29.09167	87.47933	56	104
4	E-W	28.90200	88.09883	29.11167	87.59150	30	55
5	E-W	28.60250	88.03000	28.77917	88.39467	22	51
6	W-E	28.73850	88.47950	28.55867	88.04333	26	47
7	E-W	28.50183	88.09633	28.63383	88.58833	28	51

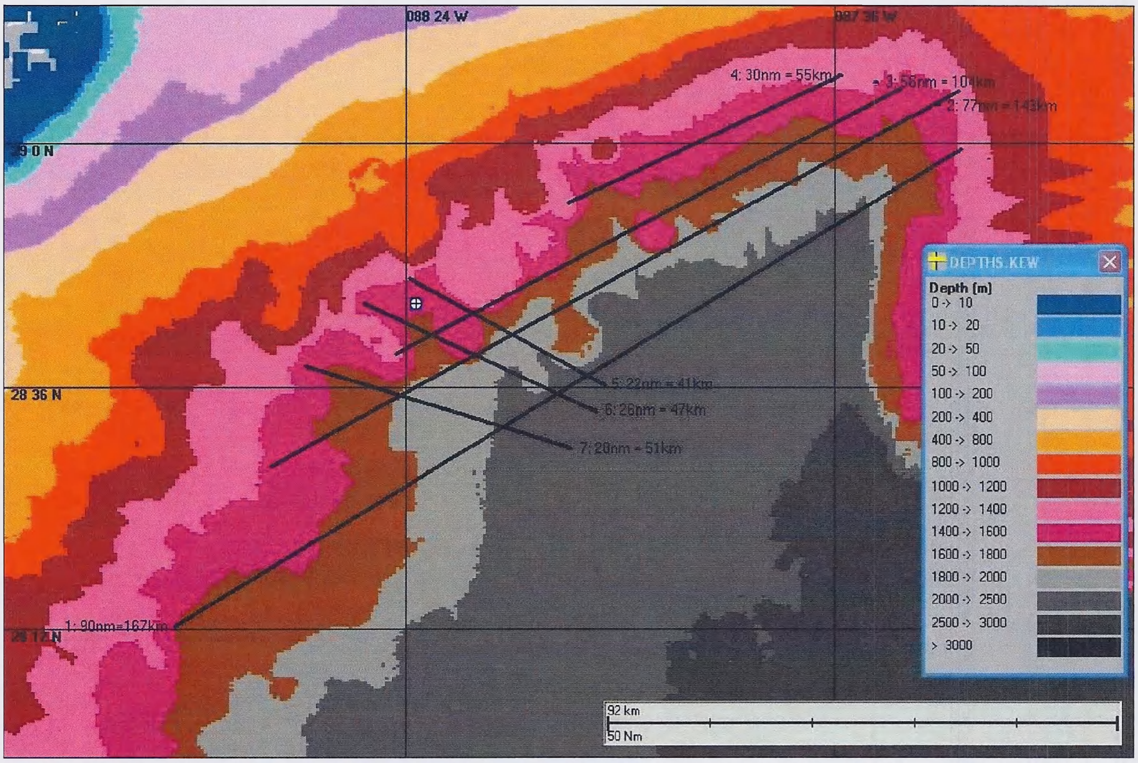

Figure 3. Transect locations for the Arctic, overlaid on bathymetry.

Methods and Instrumentation

To meet the objectives of this proposed cruise, the vessels will be outfitted with the following instrumentation to allow the acquisition of oceanographic data and water samples using the deep-tow platform on long transects, as well as by conducting casts using the TMS/ROV and rosettes bundled with instruments. Adaptive sampling locations will be selected on the basis of the preliminary data collected real-time and *in situ* by these instruments with a consideration of the extent of the area to be sampled, rate of sampling, and available crew hours. It is anticipated that, under good conditions, three (3) stations per day will be sampled on the *HOS Davis* with all gear, enabling approximately 42 stations to be sampled during the 14 operational cruise days (including up to 3 days of transit to/from port).

Ship-Board Instrumentation and Water Sampling Equipment

Nick Skansi (See Table 2):
Dual-frequency (38 kHz and 200 kHz) Simrad EK60 single-beam Echosounder

Arctic (See Table 3):
Seabird CTD
Seabird Dissolved Oxygen sensor
Fluorometers (CDOM; Chelsea AquaTracka, Attachment 1)
LISST-DEEP (Attachment 6)
ABS (Attachment 2)
MIMS (Attachment 5)
Rosette with Go-Flo bottles

HOS Davis (See Table 4):
Seabird CTD
Seabird Dissolved Oxygen sensor
Fluorometers (CDOM; ECO-Fl; Chelsea AquaTracka, Attachment 1)
Turbidity sensor
Seabird pH sensor
Mohawk ROV equipped with 20 L water sampling Go Flo Bottles (Attachment 6)
Portable Large Volume Water Sampling System (PLVWSS) (Payne et al., 1999, Attachment 8)
High-Volume Filtration (conducted by Integral personnel, Attachment 17)

Use of these instruments will enable collection of oceanographic data to characterize water column properties, including *in situ* measurements of the following chemical and physical parameters:

- Conductivity, temperature, and depth (CTD)
- Dissolved oxygen (DO)
- Fluorescence (AquaTracka, CDOM, ECO-FL)
- Turbidity
- Particle concentrations and sizes (LISST-DEEP, ABS)
- Salinity
- Density

Table 2. Acoustic Equipment aboard the M/V *Nick Skansi*.

Instrument	Manufacturer	Model	Frequency	Depth Range
Dual Echo	Simrad	EK60	38/200 kHz	1800 m
USBL	Sonardyne	7707	19-36 kHz	4000 m

Table 3. Equipment aboard the M/V *Arctic*.

Navigation	Veripos and C-Nav GPS, Sonardyne USBLs	-
Winch and armored coaxial cable	0.75" diameter 0.68" diameter	2,900 m in length 3,300 m in length
Tow-fish and MUX II		
Rosette with Go-Flo bottles		
CTD/DO & Wetlabs CDOM Fluorometer	Seabird	Water depths to 5,000 m
Chelsea AquaTracka Fluorometer	(Attachment 1)	Water depths to 5,000 m
Membrane Introduction Mass Spectrometer (MIMS; (Stanford Research Institute)	(Attachment 5)	Water depths to 2,000 m
ECO-Fl Fluorometer		
LISST-DEEP	(Attachment 6)	Water depths to 3,000 m
ABS (Aquascat 1000)	(Attachment 2)	Water depths to 1,500 m

Table 4. Equipment aboard the M/V *HOS Davis*.

Navigation	Veripos and C-Nav GPS, Sonardyne USBLs	-
Super Mohawk Remotely Operated Vehicle	SubAtlantic system, Operated by Mako	3,000 m approximate depth range
Rosette with Go-Flo bottles		
CTD/DO & Wetlabs CDOM Fluorometer	Seabird	Water depths to 5,000 m
Chelsea AquaTracka Fluorometer	(Attachment 1)	Water depths to 5,000 m
ECO-Fl Fluorometer		
Turbidity sensor		
pH sensor		

On-board equipment and monitors on these vessels will convert and display real-time data, gather and record all raw data, and provide the survey team with information relative to the presence of chemical and physical features in the water column such as dissolved oxygen minima and fluorescence maxima. Instruments are factory-calibrated. They will be used to guide the depths at which targeted water column samples will be collected according to sampling protocols. The data will also be used in selection of adaptive sampling locations.

Acoustics

Prior to deep-tow operations, the *Nick Skansi* will collect acoustic data along the survey track lines shown in Figure 1 using a dual-frequency (38 kHz and 200 kHz) Simrad EK60 single-beam echosounder or Sonardyne Model 7707 19-36 kHz system (depending on the water depth). Equipment on the *Nick Skansi* is listed in Table 2. The purpose of the acoustic surveys is two-fold: (1) collection of detailed bathymetry to understand seafloor morphology and identify potential hazards prior to deep-tow operations, and (2) potential identification of backscatter anomalies that may suggest the presence of natural seeps.

Raw acoustic data will be processed using software from EGSA, C-View, and Simrad to generate a mosaic of backscatter intensity measurements. The backscatter mosaic will be interpreted by geophysicists and technicians (on board the vessel and potentially on shore) to identify acoustic anomalies in the water column. Anomalies may be investigated using full-depth oceanographic sensors (CTD/DO and CDOM/AquaTracka fluorescence) and water sampling to characterize the water column in the vicinity of the anomaly. Vertical casts and water samples will be conducted on acoustic anomalies according to the attached water sampling protocols by the accompanying water sampling vessel.

It is anticipated that the *Arctic* will deploy the instrument towfish package during 24-hour operations to maximize sampling time and minimize retrieval time. Deep-tow operations will be conducted in areas without vessel traffic, in areas with detailed bathymetry, and only where it is operationally safe to do so.

Instrumentation Deployment

Following the acoustic survey with the M/V *Nick Skansi*, deep-tow operations on the *Arctic* using the CTD/DO, CDOM, AquaTracka fluorometer, LISST-DEEP, ABS, MIMS, and water sampling rosette mounted on the towfish platform (Figure 2) will be conducted along survey lines where operationally feasible. Deep-tow operations are conducted by raising and lowering the towfish while the vessel is moving at a slow speed (~2 knots) and conducting low-frequency oscillations between depths of 900 m and 1400 m below the sea surface. The targeted depths over which the towfish oscillates may be varied during the cruise within operational feasibility in order to examine the most prominent subsurface signals.

One aspect of this proposed Cooperative Deep-tow Cruise is to deploy the MIMS in areas north and east of the wellhead such that measurement of the concentrations of any subsurface low-molecular weight hydrocarbons (i.e., those measured by the MIMS, see below and Attachment 5) may be made. Some of the locations sampled may be in areas where natural seeps may be identified, evaluated, and characterized using the MIMS, acoustics, and other instruments, either on this cruise or in future sampling. Use of the MIMS on the present cruise will also serve as a shakedown of the instrumentation and approach for potential future use in measuring gases and low molecular weight hydrocarbons.

The underwater MIMS is capable of *in situ* detection of dissolved gases, volatile organic compounds (VOCs), and low molecular weight hydrocarbons (up to 128-amu (atomic mass unit), which includes BTEX, light alkanes, and naphthalene). Introduction of analytes into the mass spectrometer occurs through a high-pressure polydimethlyl siloxane (PDMS) membrane introduction system that has been pressure tested to a depth of 2000 m. The membrane interface used in these systems provides detection at parts per billion (ppb) levels of many VOCs and parts per million (ppm) levels for many dissolved light stable gases (see Attachment 5 "SRI International MIMS Specifications"). PAHs other than naphthalene are not detected or measured by the MIMS, nor are higher molecular weight aliphatic hydrocarbons.

A 12-bottle rosette mounted on the towfish will enable the targeted sampling of water masses on the basis of real-time data provided by the instruments. Water samples will be collected for laboratory analysis according to the NOAA QAP (detailed in the next section). Additional samples for laboratory methane and VOA analyses will be collected for comparison with *in situ* MIMS measurements, if a signal is observed indicating measurable concentrations of low molecular weight hydrocarbons at the sampling location.

Data to be generated in tab-delimited text format include:

- Location ID (sampling station number according to naming convention)
- Positional data (latitude and longitude)
- Depth
- MIMS data
- CTD/DO/CDOM/AquaTracka data
- Water bottle firing information

Reports from MIMS analyses to be generated in PDF format include:

- Dissolved gas (methane, carbon dioxide, oxygen, and nitrogen) depth profiles
- Benzene, toluene, and xylenes (BTEX) depth profiles
- Hydrogen sulfide, low molecular weight alkanes (est. ~C_2 to C_6), and naphthalene depth profiles
- Along-transect plots of dissolved concentrations with distance

Reports from CTD/DO/CDOM/AquaTracka analyses to be generated in jpg/png format include:

- Along-transect plots of signal strength with distance
- Cross-sectional plots of signal strength (color for intensity) on depth vs distance axes
- Plan-view maps of signal strength by latitude and longitude

Water Sampling

Whole water samples will be collected using sampling rosettes on the *Arctic* and either Go Flo Bottles mounted on the TMS/ROV or a sampling rosette on the *HOS Davis*. The real-time, *in situ* fluorescence and CTD/DO observations will be used as screening tools to identify the depths at which water samples will be collected. For the *HOS Davis*, the science lead (Chief Scientist) and co-lead will review the data, select the depths for sampling, and Go-Flo bottles will be tripped at the appropriate depths by the ROV (or CTD controller on the rosette) as it returns to the surface.

If either a distinct depth-zone fluorescence peak is observed and/or a distinct decrease in dissolved oxygen (DO) is observed (relative to background), then water samples will be collected as follows:

- above the indicator depth zone (fluorescence peak and/or DO minimum)
- at the maximum deflection or mid-point of the indicator depth zone (peak or minimum)
- at other locations within the indicator depth zone (e.g. if the indicator is particularly thick or if there is more than one peak)
- below the indicator depth zone

If the AquaTracka signal increases near the sea floor, or if fluorescence is observed on the sea floor using the black light and video camera on the ROV, water samples will be taken near the seafloor (as close as operationally safe: typically within 10 m).

Samples collected above and below the indicator shall be collected immediately adjacent to the observed indicator (fluorescence peak or DO minimum) but at a vertical location that is clearly outside the feature (i.e. on the background or ambient trend line of the parameter outside the influence of the perturbation). The actual depths of sample collection are at the discretion of the scientific lead(s) on each vessel based on the real-time assessment of the CTD/DO/CDOM/ AquaTracka profiles and in accordance with the above criteria.

Discretionary water samples may also be collected in the upper or mid-water column or at subtle indicator features. Discretionary sampling shall not hinder or preclude established protocols.

Standard operating procedures for water sampling and handling will be followed, and care will be taken to preserve sample integrity for hydrocarbon analyses (see Attachments 7-11 regarding sampling, handling, and decontamination procedures). Field duplicates will be collected for 10% of samples. Equipment blanks will be collected once per day (or after sampling in a particularly heavy AquaTracka lens) from different pieces of equipment. Trip blanks and temperature blanks will be included in samples for at-sea transfer and shipping.

For each sample, sufficient volumes will be collected to satisfy all analytical procedures in accordance with the NOAA MC252 Analytical QAP V2.1 (Attachment 9): Table 1.1a (extended PAH); Table 1.1b (alkane/isoprenoid and TEH); Table 1.1c (volatile aromatic hydrocarbons); Table 1.1e and f (quantitative and qualitative petroleum biomarkers); and dispersant concentrations (by LC/MS/MS), as well as methane (on the *Arctic* only). Biomarker analyses will be conducted only if there are detectable hydrocarbons.

Water sampling volumes, jar requirements, and handling procedures for each of the primary analytes are summarized in Table 5. Whole water samples for PAH and TPH analyses will be placed in 1-L I-Chem Certified Clean amber glass jars. Whole water samples for total suspended solids (TSS) and organic carbon, hydrogen, and nitrogen (CHN) analyses will be placed in 1-L non-acidified amber glass jars, clearly labeled for this dual intent. The CHN analysis will be conducted after the non-destructive TSS analysis using an elemental analyzer (micro-Dumas method). Water samples for volatile aromatic hydrocarbons (Standard List of VOCs given in AQAP v2.1 Table 1.1c) will be collected in duplicate (in 40 mL pre-acidified VOA vials with septa), and samples for methane analyses will be collected in a set of six 40-mL VOA vials with septa (three pre-acidified and three non-acidified). VOC samples may or may not be analyzed, pending agreement among the parties on the need for continued volatile analyses.

Water Filtration

The Portable Large Volume Water Sampling System (PLVWSS, Payne et al., 1999; Attachment 8) will be employed on board the *HOS Davis* in order to provide measurements of particulate and dissolved hydrocarbon concentrations. In order to maximize the number of stations that can be sampled during this cruise, the focus will be on filtering samples from locations at which the presence of subsurface oil is suggested by indicators (e.g. distinct fluorescence maxima and/or dissolved oxygen minima).

If an AquaTracka peak exceeds ~5% of the baseline and time permitting, the High Volume Filtration System may be employed along with the PLVWSS and whole water samples. The three samples will be taken simultaneously (or within minutes) from the same rosette or TMS/ROV cast. Methods for the filtering devices are detailed in appendices to this plan (Attachments 8 and 17). No more than 10 individual samples (i.e., locations and water depths) will be sampled with the multiple filtration methods during the cruise. Priority will be given to using the PLVWSS method to sample multiple depths when sensors indicate more than one or complex signals. Dr. Payne will determine stations and depths where such sampling will be performed.

Sample Containers

To supply ships with the appropriate sample containers, approximately nine (9) water samples are planned for each sampling location, plus ample additional containers to accommodate discretionary sampling and equipment blanks. Whole water sample collection, sample bottle labeling, equipment decontamination, and chain of custody procedures will be conducted in accordance with the protocols provided as appendices.

Deployment of APEX floats

The Webb Research Corporation APEX float is an autonomous drifting profiler used to measure subsurface currents and make profile measurements. It surfaces at programmed intervals to transmit profile data and its spatial displacements via IRIDIUM satellite. Standard sensors include temperature and depth.

In order to understand hydrodynamics and dispersion pattern, a total of six (6) APEX floats will be deployed as part of *M/V Arctic* cruise mission. The proposed deployment stations are located (1) in the vicinity of the well head, (2) 25 nautical miles northeast of the well head and (3) 20 nautical miles southwest of the well head (Figure 4). On each pre-determined deployment station, a set of two APEX floats will be launched. The vessel does not have to stop nor hold the position, but the floats can be deployed while the vessel undertakes her towing mission.

The APEX floats will undertake round trips from the surface to pre-determined depths (i.e., 1000-1400 m or so) in 5-day intervals, which allows for a life time of about 300 days. The floats will be set to descend from their parking depths to about 1500 m just before ascending to the surface to collect full water column profile measurements. This observational method collects real-time 5-day-interval spatial displacements, which provides information on water currents at the parking depths of the floats.

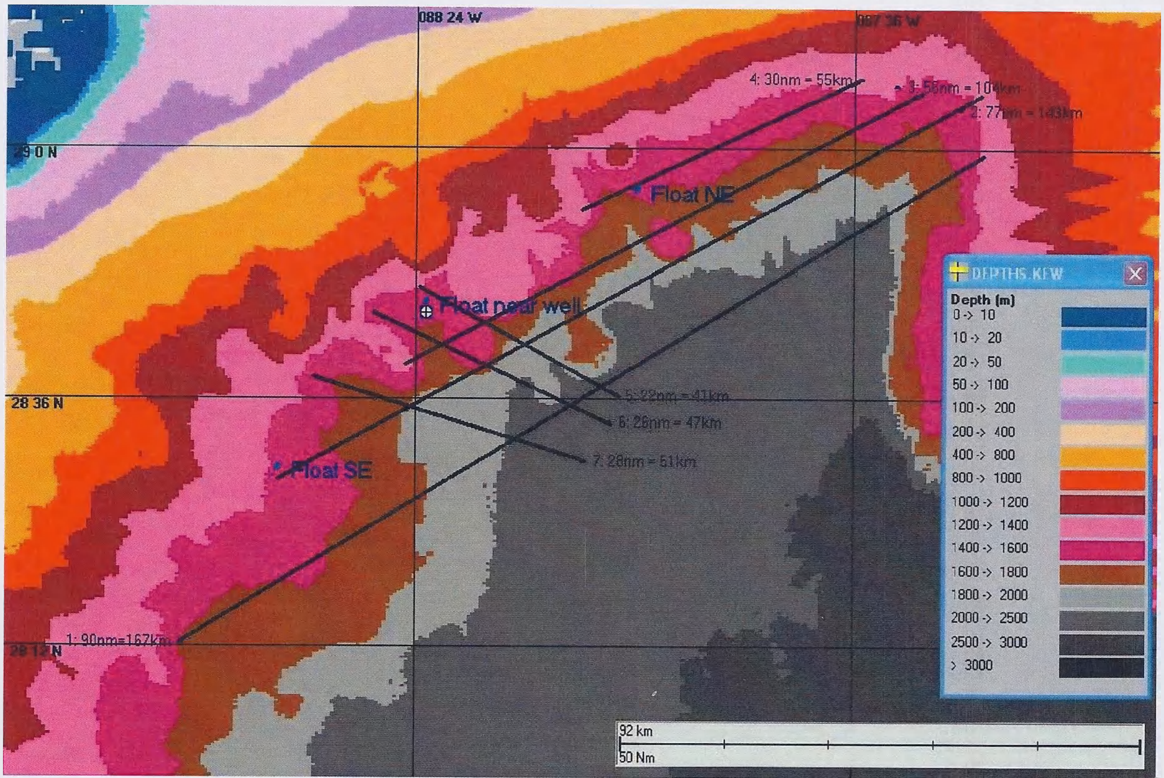

Figure 4. Proposed deployment location for pair of floats represented by blue exclamation marks and labels. One is located in the vicinity of the Deepwater Horizon incident site, one to the southwest, and one to the northeast.

Data Management and Trustee Oversight

All profile, acoustic, and other electronic data will be saved to an on-board computer, and all data shall be migrated to a dedicated hard drive. The data will be controlled and managed under project protocols, including Chain-of-Custody tracking of hard-drive. The hard-drive will be duplicated immediately following the cruise, and the original shall be kept in a secure facility.

A NOAA Data Manager on board each vessel will summarize sampling activities and scientific observations throughout the day and email NOAA NRDA (dwhnrdaWC@gmail.com) by midnight, with the following materials:

- daily report (according to the example provided as an attachment to this plan);
- PDFs of each CTD cast conducted that day (according to the example provided as an attachment to this plan).

In addition, ENTRIX will use an internal data management system to store, manage and process data from all study elements. This system will accommodate all chemistry and quality assurance data in formats compatible with BP's centralized database. A data management plan will be prepared to document the systems and procedures that will be used to ensure that data quality and data integrity are maintained throughout data management processes (see MC252 Analytical QAP and Quality Assurance Guidelines appendices).

Transfer of the shared electronic media in the onboard equipment to each of the party's hardware for retention and use: Upon return to port, the vessel Operations Manager shall produce identical copies of the raw and processed electronic media generated during the cruise and deliver one of those copies each to NOAA (or its contractor) and to ENTRIX.

Logistics

Cruise Schedule

The proposed schedule for personnel and crew of the *Arctic, HOS Davis,* and *Nick Skansi* is November 1-17, 2010. The 17 days of ship time includes two days of transit time, one day for crew change (for MIMS operators) on the *Arctic* (the *HOS Davis* will remain at sea), and 14-15 full days of sampling activities. The *Nick Skansi* will return to port after completing its missions (acoustic surveys and retrieving the two APEX floats).

The planned schedule is:

Mobilization and testing (Houma):	October 30 – November 1, 2010
QA, training, and science leads meeting:	November 1, 2010
Departure, transit, and wet testing:	November 1-2, 2010
Sampling:	November 2-8, 2010
Crew change for *Arctic* (Venice):	November 9, 2010
Sampling:	November 10-16, 2010
Return to Houma:	November 17, 2010

At-Sea Transfer of Samples

Multiple at-sea transfers of supplies and samples will be necessary to maintain the integrity of the samples and to meet laboratory hold times. Assuming samples have a maximum hold time of seven (7) days from the time of collection, at-sea transfers will be scheduled to occur after two days of sampling. A Chain of Custody (COC) will be maintained by ensuring that both a NOAA representative and a CardnoENTRIX representative are present on all transfers. Protocols for at-sea transfers and COC procedures are attached as appendices to this cruise plan (NOAA Attachments 10, 11, 15; CardnoENTRIX Appendix "Transfer of Material at Sea"). At-sea transfers will be performed by the M/V *Emily Bordelon* (140') operated by Bordelon Marine, Houma, LA. Supplies for NOAA personnel will be delivered to the Houma boat yard for at-sea transfer from the *Emily* to the receiving vessel. Samples under NOAA Chain of Custody will be unloaded at the Houma yard and taken to a sample processing facility in Baton Rouge. CardnoENTRIX resupply needs and sample intake will occur out of the Houma yard, supported by CSA according to standard cruise operations.

Sampling Equipment and Containers

Equipment:
Sampling deployment gear to sample at full depths (to 2500 m) (CSA)
Seabird CTD with dissolved oxygen sensor and CDOM fluorometer to full depths (CSA)
Chelsea Labs AquaTracka *in situ* fluorometer (CSA)
ECO-FL *in situ* fluorometer (CSA)
Go-Flo bottle samplers (CSA)
MIMS system (SRI)
LISST-DEEP (NOAA)
ABS (NOAA/ASA)
6 APEX floats

Sample Containers (per collection depth):
1-L wide-mouth amber glass jars for unfiltered PAH analysis and unfiltered TSS/CHN analysis
1-L polycarbonate (or plastic Nalgene) wide-mouth bottles for dispersant analysis
2-40 ml pre-acidified vials with septa for VOC analysis
4-15 ml centrifuge tubes for dispersant analysis
3-40 ml pre-acidified vials with septa for methane analysis (M/V *Arctic* only)
3-40 ml non-acidified vials with septa for methane analysis (M/V *Arctic* only)
Coolers

Personnel

The allocation of personnel aboard the *Arctic* is as follows:
4 Trustee/NOAA Personnel:
Dr. Yong Kim (ASA), Chief Scientist
Jennifer Cragan (ASA), Chemical Oceanographer
Steve Suttles (Green Eyes), technician
Cleve Stevens (Dade Moeller), Data Manager
2 ENTRIX Personnel
4 SRI Personnel
2 CSA Personnel
3 EGSA Personnel

The allocation of personnel aboard the *HOS Davis* is as follows:
4 NOAA contractors:
Dr. James Payne (PECI), Chief Scientist
Jennifer Aicher (AIS), Water Sampler
Lucas Curci (AIS), Water Sampler
Brock Sadler (Dade Moeller), Data Manager
3-4 ROV Technicians
1 Operation Supervisor (CSA)
1 Survey/Navigation technician (CSA)
2 field technicians (CSA)
2 ENTRIX Personnel

The allocation of personnel aboard the *Nick Skansi* is as follows:
6 EGSA Personnel
1 Trustee/NOAA Personnel
Sam Gilbo (Dade Moeller), Data Manager
1 ENTRIX Personnel
1 CSA Personnel

Vessels

All acoustic, instrumentation and sampling operations will be conducted aboard the *Arctic, HOS Davis* and *Nick Skansi*. At-sea transfers of supplies and samples will be performed by the *Emily Bordelon* operated by Bordelon Marine, Houma, LA.

Safety Plans

BP's full operations and safety plans are attached as appendices. A HASP binder is provided to each vessel. In addition, the NOAA incident site safety plan (which all NOAA employees and contractors must sign prior to the cruise) is attached (Attachment 12).

Distribution of Laboratory Results

Water samples (whole water samples, filtered water, and associated filters) for VOC, Total Hydrocarbons, and PAH analysis will be sent to Alpha Analytical Laboratories in Mansfield, MA (Table 5). Whole water samples for TSS/CHN and dispersant analyses will be sent to Columbia Analytical in Kelso, Washington by ENTRIX. Samples for methane analysis (*Arctic* only) will be sent to CalScience Lab in Garden Grove, California.

Each laboratory shall simultaneously deliver raw data, including all necessary metadata, generated as part of this work plan as a Laboratory Analytical Data Package (LADP) to the trustee Data Management Team (DMT), the Louisiana Oil Spill Coordinator's Office (LOSCO) on behalf of the State of Louisiana and to BP (or ENTRIX on behalf of BP). The electronic data deliverable (EDD) spreadsheet with pre-validated analytical results, which is a component of the complete LADP, will also be delivered to the secure FTP drop box maintained by the trustees' Data Management Team (DMT). Any preliminary data distributed to the DMT shall also be distributed to LOSCO and to BP (or ENTRIX on behalf of BP). Thereafter, the DMT will validate and perform quality assurance/quality control (QA/QC) procedures on the LADP consistent with the authorized Quality Assurance Project Plan, after which time the validated/QA/QC'd data shall be made available simultaneously to all trustees and BP (or ENTRIX on behalf of BP). Any questions raised on the validated/QA/QC results shall be handled per the procedures in the Quality Assurance Project Plan and the issue and results shall be distributed to all parties. In the interest of maintaining one consistent data set for use by all parties, only the validated/QA/QC'd data set released by the DMT shall be considered the consensus data set. In order to assure reliability of the consensus data and full review by the parties, no party shall publish consensus data until 7 days after such data has been made available to the parties. The LADP shall not be released by the DMT, LOSCO, BP or ENTRIX prior to validation/QA/QC absent a showing of critical operational need. Should any party show a critical operational need for data prior to validation/QA/QC, any released data will be clearly marked "preliminary/unvalidated" and will be made available equally to all trustees and to BP (or ENTRIX on behalf of BP).

Table 5. Summary of water sample volumes, containers, and handling procedures required for primary analytes. Details are provided in the Water Sampling Protocol (Attachments 7-8). Analytes with an asterisk (*) will be under ENTRIX COC and sample handling procedures, and the results will be reviewed and validated by the DMT. All other analytes will be under NOAA COC and sample handling procedures.

Analyte	Sample Volume	Sample Container	Sample Handling	Holding Time	Lab
PAH (extended) TEH, Dispersant indicators (DPnB)	1 L	Amber Glass, Chem Certified Clean	4° C (refrigerate)	7 days	Alpha (Mansfield, MA)
PAH (extended) TEH, Dispersant indicators (DPnB)	4 L	Amber Glass, Chem Certified Clean	4° C (refrigerate)	7 days	Alpha (Mansfield, MA)
TSS* CHN*	1 L	Amber Glass, Chem Certified Clean	4° C (refrigerate)	7 days	CAS (Kelso, WA)
Dispersant* (DOSS)	4 x 15 mL	Centrifuge tubes	0° C (freeze)	N/A	CAS (Kelso, WA
VOA	80 mL	2 x 40 mL pre-acidified (HCl) vials w/ septa	4° C (refrigerate)	14 days	Alpha (Mansfield, MA)
Methane* (*Arctic* only)	240 mL	3 x 40 mL pre-acidified (HCl) vials w/septa 3 x 40 mL non-acidified (HCl) vials w/septa	4° C (refrigerate)	14 days	Calscience (Garden Grove, CA)
Filtration samples (Payne filtering products; aboard the *HOS Davis* only)	150 mL	Glass fiber filters associated with each 3.5 L (4 L amber glass jug) are frozen in 150 mL jars immediately after collection.	0° C (freeze)	N/A	Alpha (Mansfield, MA)
Filtration* PUFs Solids (high-volume filtering products; aboard the *HOS Davis* only)		Extended PAH Table 1.1a, Saturate hydrocarbons and Total Hydrocarbons Table 1.1b. Run biomarkers Table 1.1e and Table 1.1f at lab discretion if sufficient petrogenic hydrocarbons appear present based on total hydrocarbon and PAH analyses.	4° C (refrigerate)	7 days	Alpha (Mansfield, MA)

Budgeting

The Parties acknowledge that this budget is an estimate, and that actual costs may prove to be higher due to a number of potential factors. As soon as factors are identified that may increase the estimated cost, BP will be notified and a change order provided describing the nature and cause for the increase cost in addition to a revised budget for BP's consideration and review. The field survey costs, miscellaneous costs, and travel costs indicated in Budget Chart # 1 below shall be reimbursed by BP upon receipt of written invoices submitted by the Trustees. The Vessel Costs indicated in Budget Chart # 2 shall be paid directly by BP.

Budget Chart #1.

Field Survey Costs	Hrs/Days/Trips	Day/Hr Rate	Total
NOAA Labor (days):			
Jim Payne (PECI)	[redacted]	[redacted]	$54,000
Yong Jim (ASA)	[redacted]	[redacted]	$36,000
Jennifer Cragan (ASA)	[redacted]	[redacted]	$36,000
CTD Technician	[redacted]	[redacted]	$34,000
ABS Technician	[redacted]	[redacted]	$25,500
LISST Technician	[redacted]	[redacted]	$25,500
2 Water Samplers	[redacted]	[redacted]	$34,000
Data Manager	[redacted]	[redacted]	$25,500
	[redacted]	[redacted]	
Misc Costs Sample Handling	[redacted]	[redacted]	$11,000
	[redacted]	[redacted]	
Travel	[redacted]	[redacted]	$15,000
TOTAL			**$296,500**

Days/Trips based on 1/day Mob, 16 days Fid, 1day demobilization
Labor is estimated cost and hours

Budget Chart #2.

November Cooperative Cruise Plan Cost Table	Total
Mobilization Costs	$288,750
CSA Fleet Management and Shore Support	$131,250
SRI MIMS Costs	$252,000
Vessel Costs	$3,511,372
Total Estimated Cost	**$4,183,372**

Fuel & Lube estimates included in Vessel Cost
Vessel Costs for standby thru Dec 3 included

Reference

Payne, J.R., T.J. Reilly, and D.P. French, "Fabrication of a Portable Large-volume Water Sampling System to Support Oil Spill NRDA Efforts," in *Proceedings of the 1999 Oil Spill Conference*, American Petroleum Institute, Washington, D.C., pp. 1179-1184, 1999.

List of Appendices (NOAA)

Attachment 1. Chelsea AquaTracka Fluorometer
Attachment 2. Acoustic Backscattering Sensor (ABS)
Attachment 3. Lagrangian Floats
Attachment 4. LISST-DEEP
Attachment 5. MIMS Specifications
Attachment 6. ROV
Attachment 7. Water Sample Handling Procedures 2010-06-11_jrp
Attachment 8. PLVWSS sampling protocols in support of NRDA Cruises_050510
Attachment 9. MC252 Analytical QAP V2.1
Attachment 10. Quality Assurance Guidelines for NRDA Water Column Chemistry
Attachment 11. NRDA_Field_Sampler_Data_Management_Protocol_7_5_2010
Attachment 12. NOAA-NRDA_MC_252_Site_Safety_Plan_5.13.10
Attachment 13. MC252 HSSE Incident Reporting Final 02 May 10 rev 1
Attachment 14. CSA-Davis HSE Plan Rev 005_Final
Attachment 15. Transfer of Personnel and Material at Sea 070510
Attachment 16. MC252_Incident_SIMOPS_Plan
Attachment 17. High Volume Water Filtration Methods Protocol 090110

List of Appendices (CardnoENTRIX)

MC252 NRDA Water Column Cruise Appendices
COCs
CardnoENTRIX MC252 Chain of Custody Instructions
CardnoENTRIX MC252 Chain of Custody Template and Example CAS 103110
CardnoENTRIX MC252 Photograph and GPS COC
CardnoENTRIX Electronic Data CoC
Data Sheets
At-Sea Transfer Supply Request Template
Cooperative November Cruise Data Sheet 103110
MC252 ROV datasheet
Vessel Inventory Form
CardnoENTRIX MC252 NRDA Water Column Sample List Template with Filtering
Sampling and Data Management
CardnoENTRIX Marine Assessment Shipboard Data Management Procedures 103110
CardnoENTRIX MC252 NRDA Checklist for Electronic Data Transfer at Cruise Completion
CardnoENTRIX MC252 NRDA Water Column Cruise Daily Cruise Report (DCR) Template
CardnoENTRIX MC252 NRDA Water Column Cruise Daily Operations Checklist
CardnoENTRIX MC252 NRDA Water Column Cruise Decontamination Procedures
CardnoENTRIX MC252 NRDA Water Column Cruise Procedure for Collecting Equipment Blanks
CardnoENTRIX MC252 NRDA Water Column Cruise Roles and Responsibilities
CardnoENTRIX MC252 NRDA Water Column Cruise Sample Packing Guidelines
CardnoENTRIX MC252 NRDA Water Column CTD Plot Standards
CardnoENTRIX MC252 NRDA Water Column Electronic Photo Description
CardnoENTRIX MC252 NRDA Water Column QAQC Overview
CardnoENTRIX MC252 NRDA Water Column Sample Handling Procedures
CardnoENTRIX MC252 NRDA Water Column Sample Naming Convention 103110
CardnoENTRIX SOP for Decontamination Procedures for Field Activities
Cooperative November Cruise Staffing and Contacts 103110
MC252 Analytical QAP V2.1
Equipment, Vessel, and Instrument Specifications
CSA Research Fleet 102910
CSA Vessel Contacts 102910
MIMS Specifications SRI
UVAquatracka Specifications Chelsea Instruments
Vessel Specifications: MV Arctic
Vessel Specifications: MV Emily Bordelon

[continued]

List of Appendices (CardnoENTRIX) [continued]

Vessel Specifications: MV HOS Davis
Vessel Specifications: MV Nick Skansi
Safety
BP IH Short Form
BP IIR Short Form
BP MC252 Incident Reporting Short Form Rev4
CardnoENTRIX CSA Next of Kin List
CardnoENTRIX MC252 NRDA HSE Directions from dock to hospital
CardnoENTRIX MC252 NRDA Water Column Transfer of Material at Sea
CardnoENTRIX MC252 Tailgate Safety QA Meeting Form
HSE Plan CardnoENTRIX NRDA Water Column Cruise 103010
Houma Incident Command PFD Requirements Jul 2010
ICS 213 Deepwater Horizon Heat Stress Management Plan 052810
Material Safety Data Sheet: Hexane_MSDS_03-16-2010
Material Safety Data Sheet: Hydrochloric Acid_MSDS_Feb 2010
Material Safety Data Sheet: Liquinox_MSDS_english_ansi
Material Safety Data Sheet: Methanol_MSDS_US_06-25-2010
MC252 Incident Reporting Standing Order
MC252 Lightning and Tornado Plan Jun 2010
MC252_Incident_SIMOPS_Plan_May10_2010_Rev2
NOLA UAC Heat Stress Plan Aug 2010
"Used Material" Label
"Hazardous Material" Label
SIC Protocols
SIC NRDA SOPs PowerPoint Slides (11)
SIC NRDA SOPs Word Documents (11)
Contact With Questions
Jodi Harney, jharney@entrix.com, 407-408-3154

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